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THE DISTRIBUTION OF *Callianassa* SPECIES (CRUSTACEA, DECAPODA) IN WESTERN PORT, VICTORIA

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Abstract: A recent survey has shown three species of the shrimp genus *Callianassa* to be widespread in Western Port, Victoria. *C. arenosa* Poore and *C. australiensis* (Dana) occur mainly in intertidal and shallow (<10 m) subtidal areas while the range of *C. limosa* Poore extends into deeper (>10 m) areas. *C. arenosa* and *C. limosa* were found in muddier sediments than those in which *C. australiensis* was taken. The presence of vegetation and shell debris in sediments reduced population densities and the frequency of occurrence of all species.

The relationships between the distribution of *Callianassa* and sediment type in Western Port are compared with those reported for these species in other areas.

INTRODUCTION

Port Phillip Bay and Western Port, two adjacent Victorian bays, have in common several species of the shrimp genus *Callianassa*. The distribution and sediment relationships of the species in Port Phillip Bay have already been described (Poore 1975). Detailed information for the species in Western Port is not available but recent benthic surveys (Coleman *et al.* 1978, Coleman unpublished) suggest that the environmental relationships of *Callianassa* there may differ from those in Port Phillip. This paper reports on an investigation of the abundance, distribution and sediment preferences of the three most abundant species of *Callianassa* in Western Port.

SURVEY AREA

Western Port (Fig. 1) is a marine embayment about 60 km southeast of Melbourne. The bay has a total area of approximately 1450 km² but, because of the presence of French and Phillip Islands, the water surface area is only 680 km² of which about 40% (270 km²) is intertidal. The bay has two deep water channels, North and East Arms, which partially surround French Island. The sediment in these channels is mainly medium to coarse sand. North of French Island are extensive tidal flats which drain through permanent drainage channels into North and East Arms. The sediment of these flats varies from fine sand to silt and clay. Vegetation, mainly seagrass, is found abundantly along the edges of the drainage channels and more sparsely on the rest of the tidal flats. Fine sediment with varying amounts of vegetation is found in other intertidal and shallow areas, along the edges of North and East Arms, on the spits in North Arm, and in the East Arm Embayment Plain (Ministry for Conservation 1975).

METHODS

A map of Western Port was divided into nine strata based on sediment type (Shepard classification, Ministry for Conservation 1975: Fig. 4.1.4(b)).

Ninety-seven stations were randomly allocated to these strata (Fig. 1), each stratum receiving a number of stations proportional to its area. Fifty-two stations were allocated to sand, 5 to silty-sand, 11 to clayey-sand, 1 to silt, 7 to clayey-silt, 17 to clay, 2 to sandy-clay, 1 to silty-clay and 1 to sand-silt-clay.

Stations in East Arm were sampled in April 1977 and stations in North Arm and to the north of French Island in October 1977. At each station, depth, vegetation cover and the nature of the substratum were noted. Sediment to a depth of about 40 cm was removed by divers from three 0.1 m² quadrats and sieved, on board a boat, through a 2 mm mesh. Live *Callianassa* were removed from the mesh and frozen.

The specimens were identified in the laboratory. Mean densities of each species were calculated for each of the nine original strata, for the three sandy strata (i.e. sand, silty-sand, clayey-sand) combined, for the six muddy strata combined, for three strata based on depth range (intertidal—3 m; 3-10 m; >10 m), and for twelve strata based on the field obser-

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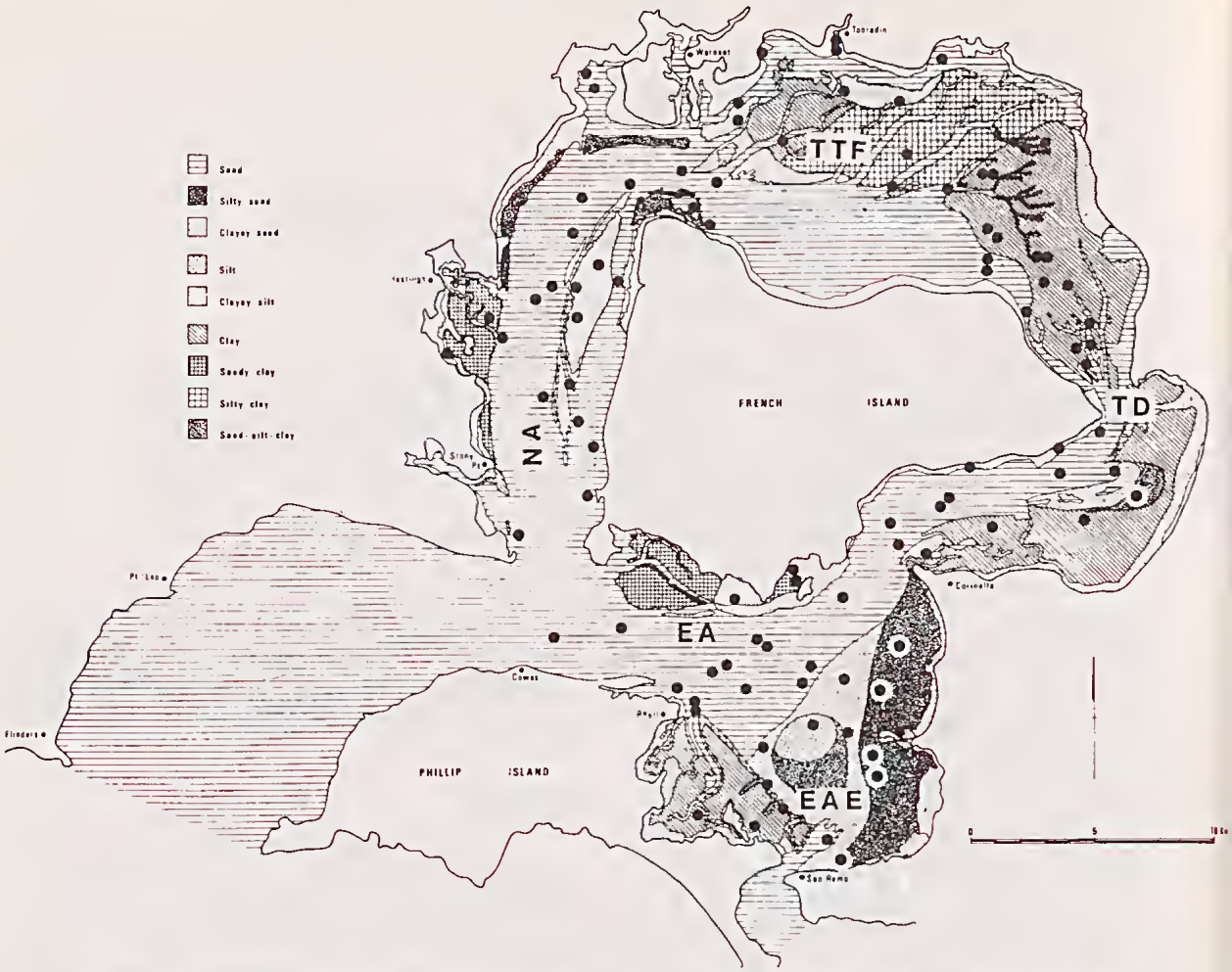

Fig. 1—Distribution of sediment types and *Callianassa* sampling stations (•) in Western Port. EA, East Arm; EAE, East Arm Embayment Plain; NA, North Arm; TTF, Tooradin Tidal Flats; TD, Tidal Divide.

vations of the amount of vegetation and shell debris present.

RESULTS

Three species of *Callianassa* were found: *C. arenosa* Poore, *C. australiensis* (Dana) and *C. limosa* Poore. Because the distribution of individuals among samples was positively skewed and because the stations were sampled during two seasons, the differences between strata were not tested statistically. In the following discussion only marked differences are assumed to reflect actual environmental preferences shown by the species.

Callianassa arenosa was the most abundant and most frequently collected species and was represented by 393 individuals from 38 stations (Fig. 2). The species was collected throughout the bay, although it was most abundant in the tidal divide region and the East Arm Embayment Plain. No individuals were found below 10 m depth but densities were similar in the two shallower strata (Table 1). *C. arenosa* was found at similar densities on sandy and muddy sediments (Table 1). Vegetation had little effect on population density but there was a tendency for *C. arenosa* to occur in fewer samples from areas with the greatest seagrass cover (Table 2). An increase in shell content of the substratum was associated with decreases in both population density and frequency of occurrence.

Callianassa australiensis was the second most abundant but the least frequently encountered species, 256 individuals at only nine stations (Fig. 3). *C. australiensis* co-occurred with *C. arenosa* at four stations and with *C. limosa* at one station but was more restricted than the other species in its sediment associa-

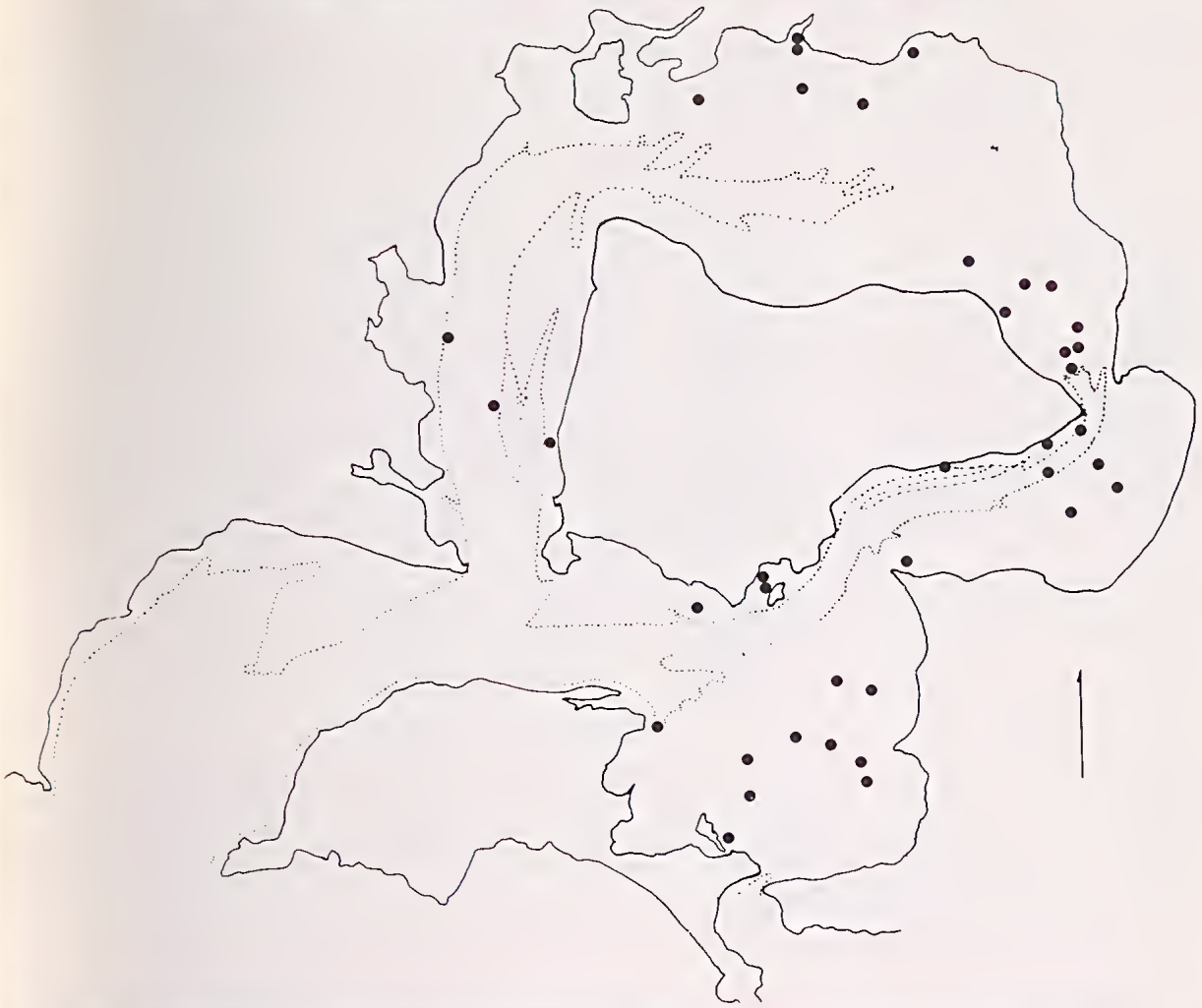

Fig. 2—Distribution of *Callianassa arenosa* in Western Port. Dots indicate survey stations at which *C. arenosa* was found. The dotted line indicates the 5.5 m depth contour.

tions, being found only in sand (Table 1). Its distribution was patchy but it was most abundant in North Arm; no specimens were collected from the Tooradin tidal flats or from the East Arm Embayment Plain. *C. australiensis* preferred shallower areas (Table 1) and was most abundant between 3 and 10 m. In general, stations with greatest vegetation cover or shell content had lowest population densities but one shelly, seagrass-covered station was exceptional in having a particularly high number of shrimps (Table 2).

TABLE 1
MEAN DENSITIES (NUMBER PER SQUARE METRE) OF THREE SPECIES OF *Callianassa* ON DIFFERENT SEDIMENT TYPES AND AT DIFFERENT DEPTHS IN WESTERN PORT.

	Sandy	Muddy	<3 m	3-10 m	>10 m
Callianassa arenosa	12.8	13.0	17.4	12.6	0.0
C. australiensis	12.3	0.0	6.5	16.1	0.2
C. limosa	9.0	4.8	4.5	11.4	10.0
Number of Stations	68	29	50	32	15

Callianassa limosa was the least abundantly collected species (220 individuals) but was widely distributed in the eastern part of the bay (Fig. 4). It was found also at one station at the southern end of North Arm. Unlike the other two species, *C. limosa* was well represented at the deeper stations and showed no preference for sandy or muddy sediments (Table 1). Increase in vegetation cover was associated with decrease in population density and frequency of occurrence of *C. limosa* although, as with *C. australiensis*, this general trend is obscured by one exceptional station. In the absence of vegetation, increase in sediment debris was associated with increases in population density and frequency of occurrence, but these effects were reduced where vegetation cover was greater.

TABLE 2

DENSITIES OF *Callianassa* SPECIES (NUMBERS PER SQUARE METRE) AND PERCENTAGE OF STATIONS AT WHICH EACH SPECIES OCCURRED (IN BRACKETS) IN TWELVE STRATA. STRATA ARE DEFINED ON THE AMOUNT OF SEAGRASS OR ALGAL COVER AND AMOUNT OF SHELL DEBRIS IN THE SEDIMENT. A DASH INDICATES ABSENCE.

Shell Content	Seagrass or Algal Cover				
	None	Low	Moderate	High	Total
Callianassa arenosa					
Low	19.7(45)	28.0(78)	18.7(60)	22.7(33)	22.0(52)
Moderate	9.0(60)	10.0(50)	10.0(50)	—	8.0(46)
High	4.7(24)	1.0(29)	—	8.3(16)	5.0(21)
Total	12.1(38)	15.1(56)	12.7(44)	12.0(20)	13.4(39)
C. australiensis					
Low	15.3(18)	40.3(33)	—	—	16.7(16)
Moderate	5.7(14)	—	—	55.0(50)*	11.7(15)
High	—	—	—	—	—
Total	7.7(10)	20.3(17)	—	5.5(5)	2.6(9)
C. limosa					
Low	6.7(27)	26.0(44)*	8.7(20)	1.0(16)	10.3(29)
Moderate	6.3(43)	—	—	—	3.3(23)
High	7.7(43)	7.0(29)	—	3.0(8)	6.0(29)
Total	7.0(36)	15.7(33)	4.8(11)	2.3(10)	7.5(28)
Number of Stations					
Low	22	2	5	6	42
Moderate	7	2	2	2	13
High	21	7	2	12	42
Total	50	18	9	20	97

*Indicates presence of a single unusally high value

DISCUSSION

Callianassa arenosa, C. australiensis and *C. limosa* are all widely and abundantly distributed in Western Port. However, this study has shown that several factors may be important in determining the patterns of occurrence observed in the bay. Differences in substrate, water depth, extent of seagrass cover and amount of shell debris all appear to influence the distribution and local abundance of the three species examined.

The presence of a moderate to high vegetation cover reduced the frequency of occurrence of all species. The reduction is presumably due to the plants' restriction of the area available for colonisation and to the difficulty in burrowing where seagrass roots are dense. However, it is not clear why *C. arenosa* alone can maintain quite high population densities in vegetated areas. Similarly, the presence of shell debris in the substratum may hinder burrowing but *C. limosa* seems less affected than the other species. Maximum densities of all three species were found in areas with slight vegetation cover, possibly because this provided a source of organic material and promoted sediment stability.

There was no station at which all three species were found together, but each species did occur with one of the others. Co-occurrences of *C. australiensis* with *C. limosa* (1 station) and of *C. arenosa* with *C. australiensis* (3 stations) were rare. *C. arenosa* and *C. limosa* were found together at sixteen stations. Since *C. arenosa* was found at thirty-seven stations and *C. limosa* at twenty-six, their co-occurrence at sixteen stations indicates a considerable degree of overlap in distribution. In these cases of spatial co-existence one species was generally much more abundant than the other, but patterns of dominance may change with time. A year's survey of a site on the northern tidal flats (Coleman, unpublished) showed that the ratio of *C. arenosa* to *C. australiensis* changed from 1:0.2 to 1:3.3 in six months and then returned to 1:0.2. Such temporal changes may reflect migration between areas or differences in reproductive behaviour.

Callianassa were absent from the deeper channel areas, presumably because strong water currents

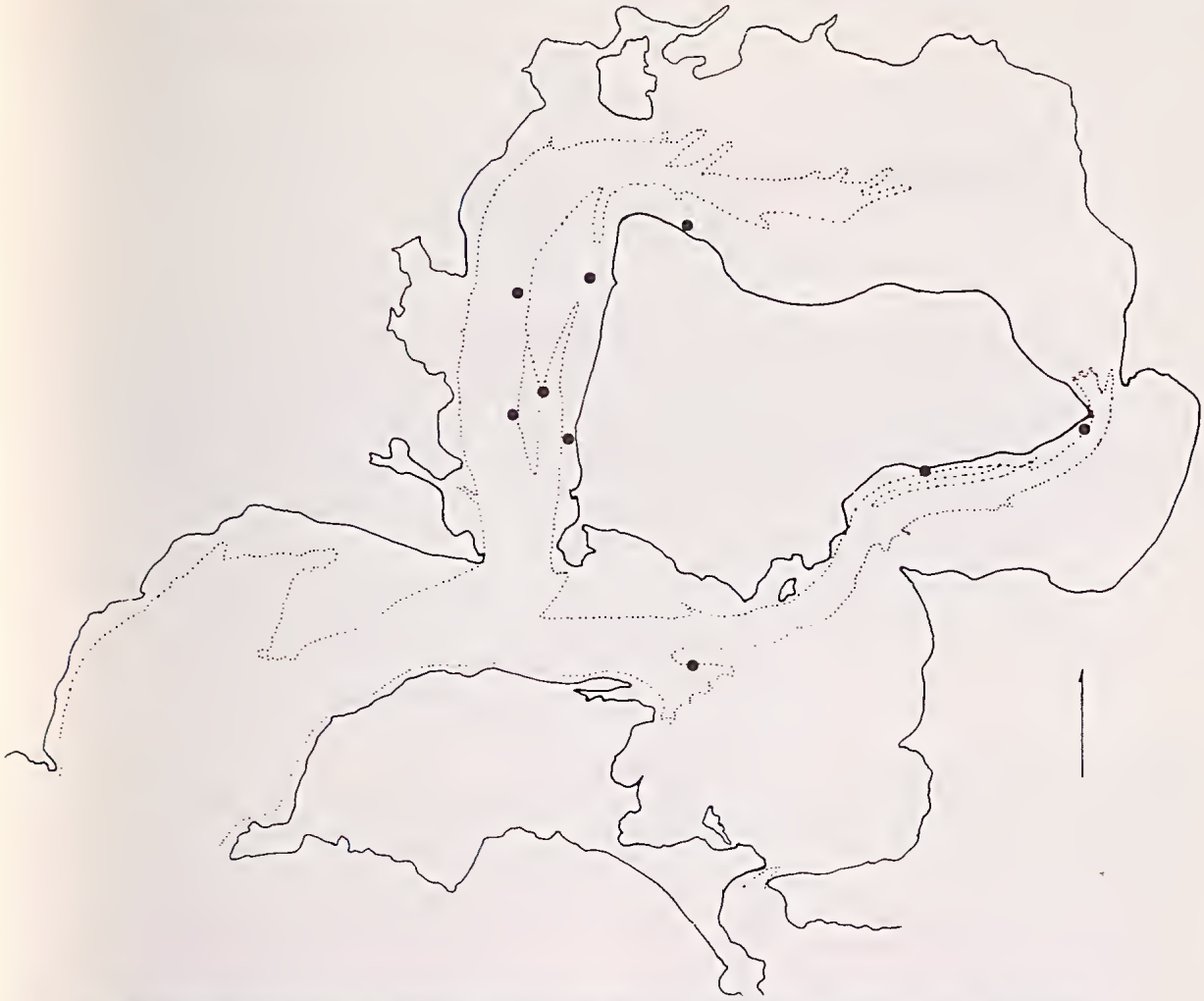

Fig. 3—Distribution of *Callianassa australiensis* in Western Port. Dots indicate survey stations at which *C. australiensis* was found. The dotted line indicates the 5.5 m depth contour.

and sediment mobility make this environment too unstable. Harder to understand was the absence of *Callianassa* from a large area in the north-east of the bay. Of nine stations in this region, five were quite shelly and/or heavily vegetated but four stations along the Tooradin — Lang Lang coast seemed suitable for *C. arenosa* and *C. australiensis*. This absence may reflect patchiness in distribution, for a subsequent more intensive survey of this area has shown that *C. arenosa* and *C. australiensis* do occur there.

Hailstone and Stephenson (1961) have reported *C. australiensis* in Queensland from gently sloping intertidal flats of fine sand with little mud, and less commonly from other intertidal substrates and the subtidal zone. The distribution of *C. australiensis* in Western Port is similar to that found in Queensland. The densities estimated by Hailstone and Stephenson (1961) of 250-500 individuals per square metre were considerably higher than those encountered in the present survey, but similar densities have been recorded in Western Port (Coleman, unpublished).

In Port Phillip Bay, *Callianassa arenosa* inhabits silty-sand between 13 and 19 m depth (Poore 1975). In contrast, the greatest densities of this species in Western Port were in the intertidal to immediate-subtidal zone, but the sediment preferences displayed are similar. In both bays *C. arenosa* avoid the deepest sediments although in Port Phillip Bay these were of fine silty-clay and in Western Port coarse shelly sand. *Callianassa limosa* is the deepest occurring species in both Port Phillip Bay (Poore 1975) and Western Port. In both bays the species was found in stable sediments; in Port Phillip Bay these are of mud, largely free of shell debris and plants, but in Western Port they are

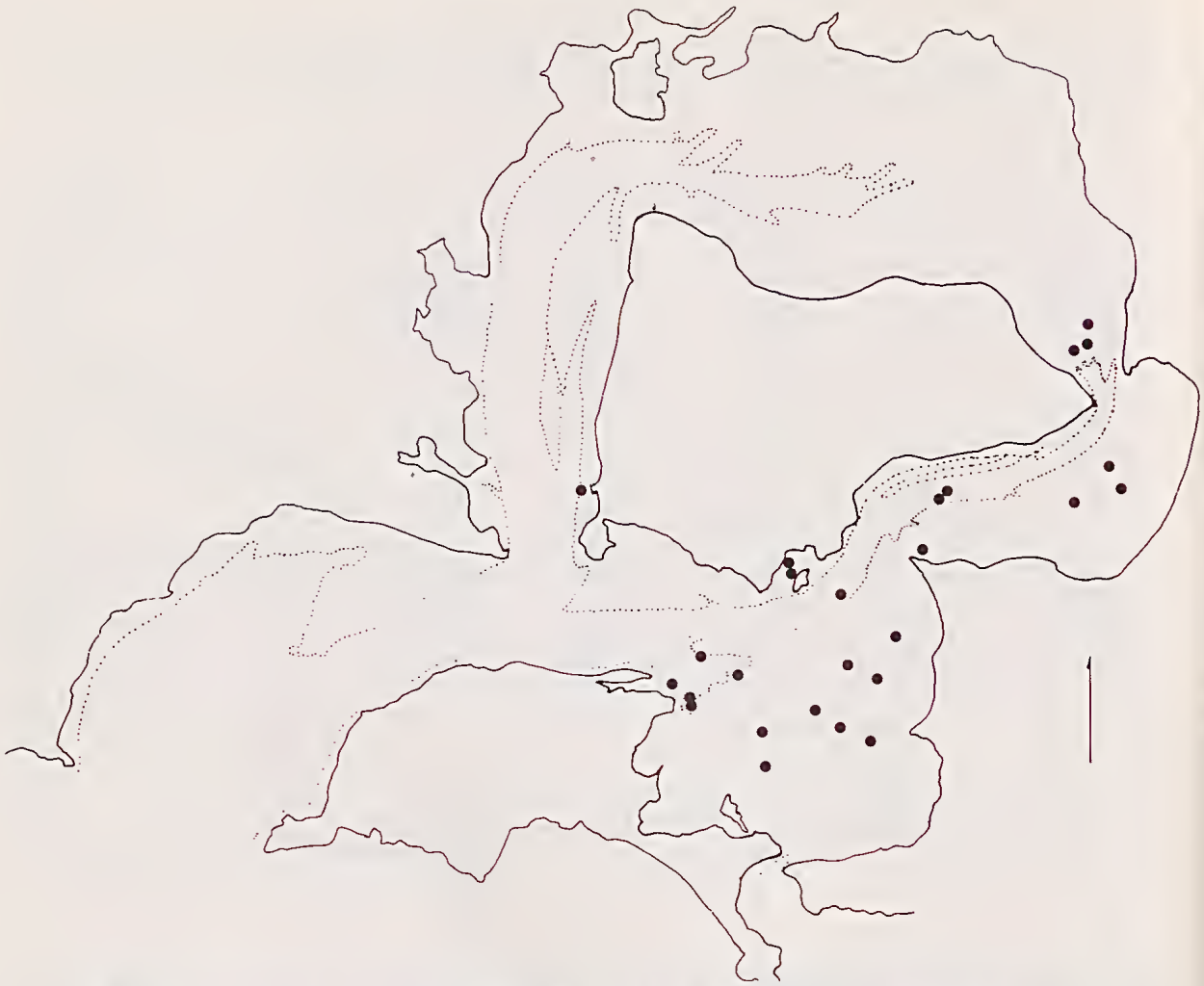

Fig. 4—Distribution of *Callianassa limosa* in Western Port. Dots indicate survey stations at which *C. limosa* was found, dotted line the 5.5 m depth contour.

poorly sorted coarser sediments, sometimes bound by plants (*Caulerpa* spp.). In Port Phillip Bay *Callianassa australiensis* is uncommon.

Three other species of *Callianassa* have been reported from Western Port. *C. ceramica* Fulton and Grant is common in Port Phillip Bay (Poore 1975) but is known only from Shoreham and San Remo ocean beach in Western Port (Poore & Griffin 1979). *C. aequimana* Baker has been collected from Shoreham and Crib Point and *C. tooradin* Poore and Griffin is known from four specimens collected at Crib Point in 1965 (Poore & Griffin 1979). None of these species was found in the present survey.

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